

AD A 043090

(1)

HIGH ENERGY NITROGEN COMPOUNDS

FINAL REPORT

GEORGE A. OLAM

APRIL 1, 1972 - MARCH 31, 1975

U. S. ARMY RESEARCH OFFICE

DA-ARO-D-31-72-G 157

CASE WESTERN RESERVE UNIVERSITY

CLEVELAND, OHIO

44106

*Good
1/3*

AD No. —
DDC FILE COPY

JUL 19 1977

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) HIGH ENERGY NITROGEN COMPOUNDS		5. TYPE OF REPORT & PERIOD COVERED FINAL, 4-1-72 - 3-31-75
7. AUTHOR(s) GEORGE A. PLAH		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS CASE WESTERN RESERVE UNIVERSITY DEPT. OF CHEMISTRY CLEVELAND, OHIO 44106		8. CONTRACT OR GRANT NUMBER(s) DA-ARO-D-31-124-72-G157
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Research Office Post Office Box 12211 Research Triangle Park, NC 27709		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Final report. 1 Apr 72 - 31 Mar 75		12. REPORT DATE 4-1-72 - 3-31-75
		13. NUMBER OF PAGES 4
		15. SECURITY CLASS. (of this report) Unclassified
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE NA
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) NA		
18. SUPPLEMENTARY NOTES The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Nitration, TNT, TNB		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The fundamental mechanistic aspects of the nitration of toluene to 2,4,6-tri-nitrotoluene (TNT) and benzene to 1,3,5-trinitrobenzene (TNB) were studied. Studies included rate studies (based on product analysis) and studies of reactive intermediates, including Fourier transfer ^{13}C nuclear magnetic resonance and X-ray photo electron spectroscopic (ESCA) studies. An effective preparation method for the direct trinitration of benzene was achieved to prepare TNB in good yield and high purity. New selective nitration methods were found for preparation of nitro-aromatic compounds. The nitration of aliphatic compounds was also studied.		

44-11 131

HIGH ENERGY NITROGEN COMPOUNDS

FORWARD

The objective of the work was to extend our knowledge of electrophilic nitration, including the new area of aliphatic electrophilic nitration, to prepare new high energy nitrogen compounds and/or to substantially improve preparative route to known high energy compounds such as TNT and TNB (1,3,5-trinitrobenzene)

Results and Conclusions

All objectives of the research project were met. The mechanism of the electrophilic nitration of toluene to trinitrotoluene (TNT) as well that of benzene to trinitrobenzene (TNB) was studied. Results disclosed a basic mechanistic difference between the mononitration step, and the di- and trinitration steps. Studies included rate studies via product analysis and study of reactive intermediates including the application of ^{13}C Fourier transform nmr and X-ray Induced Photoelectron spectroscopic methods. Comparison of solution nitration with gaseous molecule ion reactions, where no solvation effects are operative, was also carried out using the ion cyclotron resonance spectroscopic method. A highly efficient preparation method for the preparation of TNB was worked out.

A new selective nitration method was found in the boron trifluoride catalyzed nitration of aromatic with alkyl nitrates, particularly methyl nitrate. The method was found very selective in the mononitration of polyalkylbenzenes. It also allowed a detailed mechanistic study of the nitration of benzene, alkylbenzenes and halobenzenes in homogeneous, easy to handle systems where diffusion control of the reactions can be excluded.

The use of hydrogen fluoride and hydrogen fluoride like aminopolyhydrogen fluoride solutions was evaluated in electrophilic nitrations. These solvents have no oxidizing ability and show promise in minimizing oxidative side reactions.

The nitration of aliphatic and cycloaliphatic hydrocarbons was studied under electrophilic conditions. Preparative methods for nitroaliphatic compounds including nitroalkanes, nitroalkenes and nitroadamantane were developed.

The following list of publications refers to published papers containing details of the work.

1. J. Am. Chem. Soc. 81, 1111 (1959)
2. J. Am. Chem. Soc. 81, 1112 (1959)
3. J. Am. Chem. Soc. 81, 1113 (1959)
4. J. Am. Chem. Soc. 81, 1114 (1959)
5. J. Am. Chem. Soc. 81, 1115 (1959)
6. J. Am. Chem. Soc. 81, 1116 (1959)
7. J. Am. Chem. Soc. 81, 1117 (1959)
8. J. Am. Chem. Soc. 81, 1118 (1959)
9. J. Am. Chem. Soc. 81, 1119 (1959)
10. J. Am. Chem. Soc. 81, 1120 (1959)
11. J. Am. Chem. Soc. 81, 1121 (1959)
12. J. Am. Chem. Soc. 81, 1122 (1959)
13. J. Am. Chem. Soc. 81, 1123 (1959)
14. J. Am. Chem. Soc. 81, 1124 (1959)
15. J. Am. Chem. Soc. 81, 1125 (1959)
16. J. Am. Chem. Soc. 81, 1126 (1959)
17. J. Am. Chem. Soc. 81, 1127 (1959)
18. J. Am. Chem. Soc. 81, 1128 (1959)
19. J. Am. Chem. Soc. 81, 1129 (1959)
20. J. Am. Chem. Soc. 81, 1130 (1959)
21. J. Am. Chem. Soc. 81, 1131 (1959)
22. J. Am. Chem. Soc. 81, 1132 (1959)
23. J. Am. Chem. Soc. 81, 1133 (1959)
24. J. Am. Chem. Soc. 81, 1134 (1959)
25. J. Am. Chem. Soc. 81, 1135 (1959)
26. J. Am. Chem. Soc. 81, 1136 (1959)
27. J. Am. Chem. Soc. 81, 1137 (1959)
28. J. Am. Chem. Soc. 81, 1138 (1959)
29. J. Am. Chem. Soc. 81, 1139 (1959)
30. J. Am. Chem. Soc. 81, 1140 (1959)
31. J. Am. Chem. Soc. 81, 1141 (1959)
32. J. Am. Chem. Soc. 81, 1142 (1959)
33. J. Am. Chem. Soc. 81, 1143 (1959)
34. J. Am. Chem. Soc. 81, 1144 (1959)
35. J. Am. Chem. Soc. 81, 1145 (1959)
36. J. Am. Chem. Soc. 81, 1146 (1959)
37. J. Am. Chem. Soc. 81, 1147 (1959)
38. J. Am. Chem. Soc. 81, 1148 (1959)
39. J. Am. Chem. Soc. 81, 1149 (1959)
40. J. Am. Chem. Soc. 81, 1150 (1959)
41. J. Am. Chem. Soc. 81, 1151 (1959)
42. J. Am. Chem. Soc. 81, 1152 (1959)
43. J. Am. Chem. Soc. 81, 1153 (1959)
44. J. Am. Chem. Soc. 81, 1154 (1959)
45. J. Am. Chem. Soc. 81, 1155 (1959)
46. J. Am. Chem. Soc. 81, 1156 (1959)
47. J. Am. Chem. Soc. 81, 1157 (1959)
48. J. Am. Chem. Soc. 81, 1158 (1959)
49. J. Am. Chem. Soc. 81, 1159 (1959)
50. J. Am. Chem. Soc. 81, 1160 (1959)
51. J. Am. Chem. Soc. 81, 1161 (1959)
52. J. Am. Chem. Soc. 81, 1162 (1959)
53. J. Am. Chem. Soc. 81, 1163 (1959)
54. J. Am. Chem. Soc. 81, 1164 (1959)
55. J. Am. Chem. Soc. 81, 1165 (1959)
56. J. Am. Chem. Soc. 81, 1166 (1959)
57. J. Am. Chem. Soc. 81, 1167 (1959)
58. J. Am. Chem. Soc. 81, 1168 (1959)
59. J. Am. Chem. Soc. 81, 1169 (1959)
60. J. Am. Chem. Soc. 81, 1170 (1959)
61. J. Am. Chem. Soc. 81, 1171 (1959)
62. J. Am. Chem. Soc. 81, 1172 (1959)
63. J. Am. Chem. Soc. 81, 1173 (1959)
64. J. Am. Chem. Soc. 81, 1174 (1959)
65. J. Am. Chem. Soc. 81, 1175 (1959)
66. J. Am. Chem. Soc. 81, 1176 (1959)
67. J. Am. Chem. Soc. 81, 1177 (1959)
68. J. Am. Chem. Soc. 81, 1178 (1959)
69. J. Am. Chem. Soc. 81, 1179 (1959)
70. J. Am. Chem. Soc. 81, 1180 (1959)
71. J. Am. Chem. Soc. 81, 1181 (1959)
72. J. Am. Chem. Soc. 81, 1182 (1959)
73. J. Am. Chem. Soc. 81, 1183 (1959)
74. J. Am. Chem. Soc. 81, 1184 (1959)
75. J. Am. Chem. Soc. 81, 1185 (1959)
76. J. Am. Chem. Soc. 81, 1186 (1959)
77. J. Am. Chem. Soc. 81, 1187 (1959)
78. J. Am. Chem. Soc. 81, 1188 (1959)
79. J. Am. Chem. Soc. 81, 1189 (1959)
80. J. Am. Chem. Soc. 81, 1190 (1959)
81. J. Am. Chem. Soc. 81, 1191 (1959)
82. J. Am. Chem. Soc. 81, 1192 (1959)
83. J. Am. Chem. Soc. 81, 1193 (1959)
84. J. Am. Chem. Soc. 81, 1194 (1959)
85. J. Am. Chem. Soc. 81, 1195 (1959)
86. J. Am. Chem. Soc. 81, 1196 (1959)
87. J. Am. Chem. Soc. 81, 1197 (1959)
88. J. Am. Chem. Soc. 81, 1198 (1959)
89. J. Am. Chem. Soc. 81, 1199 (1959)
90. J. Am. Chem. Soc. 81, 1200 (1959)
91. J. Am. Chem. Soc. 81, 1201 (1959)
92. J. Am. Chem. Soc. 81, 1202 (1959)
93. J. Am. Chem. Soc. 81, 1203 (1959)
94. J. Am. Chem. Soc. 81, 1204 (1959)
95. J. Am. Chem. Soc. 81, 1205 (1959)
96. J. Am. Chem. Soc. 81, 1206 (1959)
97. J. Am. Chem. Soc. 81, 1207 (1959)
98. J. Am. Chem. Soc. 81, 1208 (1959)
99. J. Am. Chem. Soc. 81, 1209 (1959)
100. J. Am. Chem. Soc. 81, 1210 (1959)
101. J. Am. Chem. Soc. 81, 1211 (1959)
102. J. Am. Chem. Soc. 81, 1212 (1959)
103. J. Am. Chem. Soc. 81, 1213 (1959)
104. J. Am. Chem. Soc. 81, 1214 (1959)
105. J. Am. Chem. Soc. 81, 1215 (1959)
106. J. Am. Chem. Soc. 81, 1216 (1959)
107. J. Am. Chem. Soc. 81, 1217 (1959)
108. J. Am. Chem. Soc. 81, 1218 (1959)
109. J. Am. Chem. Soc. 81, 1219 (1959)
110. J. Am. Chem. Soc. 81, 1220 (1959)
111. J. Am. Chem. Soc. 81, 1221 (1959)
112. J. Am. Chem. Soc. 81, 1222 (1959)
113. J. Am. Chem. Soc. 81, 1223 (1959)
114. J. Am. Chem. Soc. 81, 1224 (1959)
115. J. Am. Chem. Soc. 81, 1225 (1959)
116. J. Am. Chem. Soc. 81, 1226 (1959)
117. J. Am. Chem. Soc. 81, 1227 (1959)
118. J. Am. Chem. Soc. 81, 1228 (1959)
119. J. Am. Chem. Soc. 81, 1229 (1959)
120. J. Am. Chem. Soc. 81, 1230 (1959)
121. J. Am. Chem. Soc. 81, 1231 (1959)
122. J. Am. Chem. Soc. 81, 1232 (1959)
123. J. Am. Chem. Soc. 81, 1233 (1959)
124. J. Am. Chem. Soc. 81, 1234 (1959)
125. J. Am. Chem. Soc. 81, 1235 (1959)
126. J. Am. Chem. Soc. 81, 1236 (1959)
127. J. Am. Chem. Soc. 81, 1237 (1959)
128. J. Am. Chem. Soc. 81, 1238 (1959)
129. J. Am. Chem. Soc. 81, 1239 (1959)
130. J. Am. Chem. Soc. 81, 1240 (1959)
131. J. Am. Chem. Soc. 81, 1241 (1959)
132. J. Am. Chem. Soc. 81, 1242 (1959)
133. J. Am. Chem. Soc. 81, 1243 (1959)
134. J. Am. Chem. Soc. 81, 1244 (1959)
135. J. Am. Chem. Soc. 81, 1245 (1959)
136. J. Am. Chem. Soc. 81, 1246 (1959)
137. J. Am. Chem. Soc. 81, 1247 (1959)
138. J. Am. Chem. Soc. 81, 1248 (1959)
139. J. Am. Chem. Soc. 81, 1249 (1959)
140. J. Am. Chem. Soc. 81, 1250 (1959)
141. J. Am. Chem. Soc. 81, 1251 (1959)
142. J. Am. Chem. Soc. 81, 1252 (1959)
143. J. Am. Chem. Soc. 81, 1253 (1959)
144. J. Am. Chem. Soc. 81, 1254 (1959)
145. J. Am. Chem. Soc. 81, 1255 (1959)
146. J. Am. Chem. Soc. 81, 1256 (1959)
147. J. Am. Chem. Soc. 81, 1257 (1959)
148. J. Am. Chem. Soc. 81, 1258 (1959)
149. J. Am. Chem. Soc. 81, 1259 (1959)
150. J. Am. Chem. Soc. 81, 1260 (1959)
151. J. Am. Chem. Soc. 81, 1261 (1959)
152. J. Am. Chem. Soc. 81, 1262 (1959)
153. J. Am. Chem. Soc. 81, 1263 (1959)
154. J. Am. Chem. Soc. 81, 1264 (1959)
155. J. Am. Chem. Soc. 81, 1265 (1959)
156. J. Am. Chem. Soc. 81, 1266 (1959)
157. J. Am. Chem. Soc. 81, 1267 (1959)
158. J. Am. Chem. Soc. 81, 1268 (1959)
159. J. Am. Chem. Soc. 81, 1269 (1959)
160. J. Am. Chem. Soc. 81, 1270 (1959)
161. J. Am. Chem. Soc. 81, 1271 (1959)
162. J. Am. Chem. Soc. 81, 1272 (1959)
163. J. Am. Chem. Soc. 81, 1273 (1959)
164. J. Am. Chem. Soc. 81, 1274 (1959)
165. J. Am. Chem. Soc. 81, 1275 (1959)
166. J. Am. Chem. Soc. 81, 1276 (1959)
167. J. Am. Chem. Soc. 81, 1277 (1959)
168. J. Am. Chem. Soc. 81, 1278 (1959)
169. J. Am. Chem. Soc. 81, 1279 (1959)
170. J. Am. Chem. Soc. 81, 1280 (1959)
171. J. Am. Chem. Soc. 81, 1281 (1959)
172. J. Am. Chem. Soc. 81, 1282 (1959)
173. J. Am. Chem. Soc. 81, 1283 (1959)
174. J. Am. Chem. Soc. 81, 1284 (1959)
175. J. Am. Chem. Soc. 81, 1285 (1959)
176. J. Am. Chem. Soc. 81, 1286 (1959)
177. J. Am. Chem. Soc. 81, 1287 (1959)
178. J. Am. Chem. Soc. 81, 1288 (1959)
179. J. Am. Chem. Soc. 81, 1289 (1959)
180. J. Am. Chem. Soc. 81, 1290 (1959)
181. J. Am. Chem. Soc. 81, 1291 (1959)
182. J. Am. Chem. Soc. 81, 1292 (1959)
183. J. Am. Chem. Soc. 81, 1293 (1959)
184. J. Am. Chem. Soc. 81, 1294 (1959)
185. J. Am. Chem. Soc. 81, 1295 (1959)
186. J. Am. Chem. Soc. 81, 1296 (1959)
187. J. Am. Chem. Soc. 81, 1297 (1959)
188. J. Am. Chem. Soc. 81, 1298 (1959)
189. J. Am. Chem. Soc. 81, 1299 (1959)
190. J. Am. Chem. Soc. 81, 1300 (1959)
191. J. Am. Chem. Soc. 81, 1301 (1959)
192. J. Am. Chem. Soc. 81, 1302 (1959)
193. J. Am. Chem. Soc. 81, 1303 (1959)
194. J. Am. Chem. Soc. 81, 1304 (1959)
195. J. Am. Chem. Soc. 81, 1305 (1959)
196. J. Am. Chem. Soc. 81, 1306 (1959)
197. J. Am. Chem. Soc. 81, 1307 (1959)
198. J. Am. Chem. Soc. 81, 1308 (1959)
199. J. Am. Chem. Soc. 81, 1309 (1959)
200. J. Am. Chem. Soc. 81, 1310 (1959)
201. J. Am. Chem. Soc. 81, 1311 (1959)
202. J. Am. Chem. Soc. 81, 1312 (1959)
203. J. Am. Chem. Soc. 81, 1313 (1959)
204. J. Am. Chem. Soc. 81, 1314 (1959)
205. J. Am. Chem. Soc. 81, 1315 (1959)
206. J. Am. Chem. Soc. 81, 1316 (1959)
207. J. Am. Chem. Soc. 81, 1317 (1959)
208. J. Am. Chem. Soc. 81, 1318 (1959)
209. J. Am. Chem. Soc. 81, 1319 (1959)
210. J. Am. Chem. Soc. 81, 1320 (1959)
211. J. Am. Chem. Soc. 81, 1321 (1959)
212. J. Am. Chem. Soc. 81, 1322 (1959)
213. J. Am. Chem. Soc. 81, 1323 (1959)
214. J. Am. Chem. Soc. 81, 1324 (1959)
215. J. Am. Chem. Soc. 81, 1325 (1959)
216. J. Am. Chem. Soc. 81, 1326 (1959)
217. J. Am. Chem. Soc. 81, 1327 (1959)
218. J. Am. Chem. Soc. 81, 1328 (1959)
219. J. Am. Chem. Soc. 81, 1329 (1959)
220. J. Am. Chem. Soc. 81, 1330 (1959)
221. J. Am. Chem. Soc. 81, 1331 (1959)
222. J. Am. Chem. Soc. 81, 1332 (1959)
223. J. Am. Chem. Soc. 81, 1333 (1959)
224. J. Am. Chem. Soc. 81, 1334 (1959)
225. J. Am. Chem. Soc. 81, 1335 (1959)
226. J. Am. Chem. Soc. 81, 1336 (1959)
227. J. Am. Chem. Soc. 81, 1337 (1959)
228. J. Am. Chem. Soc. 81, 1338 (1959)
229. J. Am. Chem. Soc. 81, 1339 (1959)
230. J. Am. Chem. Soc. 81, 1340 (1959)
231. J. Am. Chem. Soc. 81, 1341 (1959)
232. J. Am. Chem. Soc. 81, 1342 (1959)
233. J. Am. Chem. Soc. 81, 1343 (1959)
234. J. Am. Chem. Soc. 81, 1344 (1959)
235. J. Am. Chem. Soc. 81, 1345 (1959)
236. J. Am. Chem. Soc. 81, 1346 (1959)
237. J. Am. Chem. Soc. 81, 1347 (1959)
238. J. Am. Chem. Soc. 81, 1348 (1959)
239. J. Am. Chem. Soc. 81, 1349 (1959)
240. J. Am. Chem. Soc. 81, 1350 (1959)
241. J. Am. Chem. Soc. 81, 1351 (1959)
242. J. Am. Chem. Soc. 81, 1352 (1959)
243. J. Am. Chem. Soc. 81, 1353 (1959)
244. J. Am. Chem. Soc. 81, 1354 (1959)
245. J. Am. Chem. Soc. 81, 1355 (1959)
246. J. Am. Chem. Soc. 81, 1356 (1959)
247. J. Am. Chem. Soc. 81, 1357 (1959)
248. J. Am. Chem. Soc. 81, 1358 (1959)
249. J. Am. Chem. Soc. 81, 1359 (1959)
250. J. Am. Chem. Soc. 81, 1360 (1959)
251. J. Am. Chem. Soc. 81, 1361 (1959)
252. J. Am. Chem. Soc. 81, 1362 (1959)
253. J. Am. Chem. Soc. 81, 1363 (1959)
254. J. Am. Chem. Soc. 81, 1364 (1959)
255. J. Am. Chem. Soc. 81, 1365 (1959)
256. J. Am. Chem. Soc. 81, 1366 (1959)
257. J. Am. Chem. Soc. 81, 1367 (1959)
258. J. Am. Chem. Soc. 81, 1368 (1959)
259. J. Am. Chem. Soc. 81, 1369 (1959)
260. J. Am. Chem. Soc. 81, 1370 (1959)
261. J. Am. Chem. Soc. 81, 1371 (1959)
262. J. Am. Chem. Soc. 81, 1372 (1959)
263. J. Am. Chem. Soc. 81, 1373 (1959)
264. J. Am. Chem. Soc. 81, 1374 (1959)
265. J. Am. Chem. Soc. 81, 1375 (1959)
266. J. Am. Chem. Soc. 81, 1376 (1959)
267. J. Am. Chem. Soc. 81, 1377 (1959)
268. J. Am. Chem. Soc. 81, 1378 (1959)
269. J. Am. Chem. Soc. 81, 1379 (1959)
270. J. Am. Chem. Soc. 81, 1380 (1959)
271. J. Am. Chem. Soc. 81, 1381 (1959)
272. J. Am. Chem. Soc. 81, 1382 (1959)
273. J. Am. Chem. Soc. 81, 1383 (1959)
274. J. Am. Chem. Soc. 81, 1384 (1959)
275. J. Am. Chem. Soc. 81, 1385 (1959)
276. J. Am. Chem. Soc. 81, 1386 (1959)
277. J. Am. Chem. Soc. 81, 1387 (1959)
278. J. Am. Chem. Soc. 81, 1388 (1959)
279. J. Am. Chem. Soc. 81, 1389 (1959)
280. J. Am. Chem. Soc. 81, 1390 (1959)
281. J. Am. Chem. Soc. 81, 1391 (1959)
282. J. Am. Chem. Soc. 81, 1392 (1959)
283. J. Am. Chem. Soc. 81, 1393 (1959)
284. J. Am. Chem. Soc. 81, 1394 (1959)
285. J. Am. Chem. Soc. 81, 1395 (1959)
286. J. Am. Chem. Soc. 81, 1396 (1959)
287. J. Am. Chem. Soc. 81, 1397 (1959)
288. J. Am. Chem. Soc. 81, 1398 (1959)
289. J. Am. Chem. Soc. 81, 1399 (1959)
290. J. Am. Chem. Soc. 81, 1400 (1959)
291. J. Am. Chem. Soc. 81, 1401 (1959)
292. J. Am. Chem. Soc. 81, 1402 (1959)
293. J. Am. Chem. Soc. 81, 1403 (1959)
294. J. Am. Chem. Soc. 81, 1404 (1959)
295. J. Am. Chem. Soc. 81, 1405 (1959)
296. J. Am. Chem. Soc. 81, 1406 (1959)
297. J. Am. Chem. Soc. 81, 1407 (1959)
298. J. Am. Chem. Soc. 81, 1408 (1959)
299. J. Am. Chem. Soc. 81, 1409 (1959)
300. J. Am. Chem. Soc. 81, 1410 (1959)
301. J. Am. Chem. Soc. 81, 1411 (1959)
302. J. Am. Chem. Soc. 81, 1412 (1959)
303. J. Am. Chem. Soc. 81, 1413 (1959)
304. J. Am. Chem. Soc. 81, 1414 (1959)
305. J. Am. Chem. Soc. 81, 1415 (1959)
306. J. Am. Chem. Soc. 81, 1416 (1959)
307. J. Am. Chem. Soc. 81, 1417 (1959)
308. J. Am. Chem. Soc. 81, 1418 (1959)
309. J. Am. Chem. Soc. 81, 1419 (1959)
310. J. Am. Chem. Soc. 81, 1420 (1959)
311. J. Am. Chem. Soc. 81, 1421 (1959)
312. J. Am. Chem. Soc. 81, 1422 (1959)
313. J. Am. Chem. Soc. 81, 1423 (1959)
314. J. Am. Chem. Soc. 81, 1424 (1959)
315. J. Am. Chem. Soc. 81, 1425 (1959)
316. J. Am. Chem. Soc. 81, 1426 (1959)
317. J. Am. Chem. Soc. 81, 1427 (1959)
318. J. Am. Chem. Soc. 81, 1428 (1959)
319. J. Am. Chem. Soc. 81, 1429 (1959)
320. J. Am. Chem. Soc. 81, 1430 (1959)
321. J. Am. Chem. Soc. 81, 1431 (1959)
322. J. Am. Chem. Soc. 81, 1432 (1959)
323. J. Am. Chem. Soc. 81, 1433 (1959)
324. J. Am. Chem. Soc. 81, 1434 (1959)
325. J. Am. Chem. Soc. 81, 1435 (1959)
326. J. Am. Chem. Soc. 81, 1436 (1959)
327. J. Am. Chem. Soc. 81, 1437 (1959)
328. J. Am. Chem. Soc. 81, 1438 (1959)
329. J. Am. Chem. Soc. 81, 1439 (1959)
330. J. Am. Chem. Soc. 81, 1440 (1959)
331. J. Am. Chem. Soc. 81, 1441 (1959)
332. J. Am. Chem. Soc. 81, 1442 (1959)
333. J. Am. Chem. Soc. 81, 1443 (1959)
334. J. Am. Chem. Soc. 81, 1444 (1959)
335. J. Am. Chem. Soc. 81, 1445 (1959)
336. J. Am. Chem. Soc. 81, 1446 (1959)
337. J. Am. Chem. Soc. 81, 1447 (1959)
338. J. Am. Chem. Soc. 81, 1448 (1959)
339. J. Am. Chem. Soc. 81, 1449 (1959)
340. J. Am. Chem. Soc. 81, 1450 (1959)
341. J. Am. Chem. Soc. 81, 1451 (1959)
342. J. Am. Chem. Soc. 81, 1452 (1959)
343. J. Am. Chem. Soc. 81, 1453 (1959)
344. J. Am. Chem. Soc. 81, 1454 (1959)
345. J. Am. Chem. Soc. 81, 1455 (1959)
346. J. Am. Chem. Soc. 81, 1456 (1959)
347. J. Am. Chem. Soc. 81, 1457 (1959)
348. J. Am. Chem. Soc. 81, 1458 (1959)
349. J. Am. Chem. Soc. 81, 1459 (1959)
350. J. Am. Chem. Soc. 81, 1460 (1959)
351. J. Am. Chem. Soc. 81, 1461 (1959)
352. J. Am. Chem. Soc. 81, 1462 (1959)
353. J. Am. Chem. Soc. 81, 1463 (1959)
354. J. Am. Chem. Soc. 81, 1464 (1959)
355. J. Am. Chem. Soc. 81, 1465 (1959)
356. J. Am. Chem. Soc. 81, 1466 (1959)
357. J. Am. Chem. Soc. 81, 1467 (1959)
358. J. Am. Chem. Soc. 81, 1468 (1959)
359. J. Am. Chem. Soc. 81, 1469 (1959)
360. J. Am. Chem. Soc. 81, 1470 (1959)
361. J. Am. Chem. Soc. 81, 1471 (1959)
362. J. Am. Chem. Soc. 81, 1472 (1959)
363. J. Am. Chem. Soc. 81, 1473 (1959)
364. J. Am. Chem. Soc. 81, 1474 (1959)
365. J. Am. Chem. Soc. 81, 1475 (1959)
366. J. Am. Chem. Soc. 81, 1476 (1959)
367. J. Am. Chem. Soc. 81, 1477 (1959)
368. J. Am. Chem. Soc. 81, 1478 (1959)
369. J. Am. Chem. Soc. 81, 1479 (1959)
370. J. Am. Chem. Soc. 81, 1480 (1959)
371. J. Am. Chem. Soc. 81, 1481 (1959)
372. J. Am. Chem. Soc. 81, 1482 (1959)
373. J. Am. Chem. Soc. 81, 1483 (1959)
374. J. Am. Chem. Soc. 81, 1484 (1959)
375. J. Am. Chem. Soc. 81, 1485 (1959)
376. J. Am. Chem. Soc. 81, 1486 (1959)
377. J. Am. Chem. Soc. 81, 1487 (1959)
378. J. Am. Chem. Soc. 81, 1488 (1959)
379. J. Am. Chem. Soc. 81, 1489 (1959)
380. J. Am. Chem. Soc. 81, 1490 (1959)
381. J. Am. Chem. Soc. 81, 1491 (1959)
382. J. Am. Chem. Soc. 81, 1492 (1959)
383. J. Am. Chem. Soc. 81, 1493 (1959)
384. J. Am. Chem. Soc. 81, 1494 (1959)
385. J. Am. Chem. Soc. 81, 1495 (1959)
386. J. Am. Chem. Soc. 81, 1496 (1959)
387. J. Am. Chem. Soc. 81, 1497 (1959)
388. J. Am. Chem. Soc. 81, 1498 (1959)
389. J. Am. Chem. Soc. 81, 1499 (1959)
390. J. Am. Chem. Soc. 81, 1500 (1959)
391. J. Am. Chem. Soc. 81, 1501 (1959)
392. J. Am. Chem. Soc. 81, 1502 (1959)
393. J. Am. Chem. Soc. 81, 1503 (1959)
394. J. Am. Chem. Soc. 81, 1504 (1959)
395. J. Am. Chem. Soc. 81, 1505 (1959)
396. J. Am. Chem. Soc. 81, 1506 (1959)
397. J. Am. Chem. Soc. 81, 1507 (1959)
398. J. Am. Chem. Soc. 81, 1508 (1959)
399. J. Am. Chem. Soc. 81, 1509 (1959)
400. J. Am. Chem. Soc. 81, 1510 (1959)
401. J. Am. Chem. Soc. 81, 1511 (1959)
402. J. Am. Chem. Soc

R. C. Dunbar, J. Shen and G. A. Olah. "Substituent Effects in Gas-Phase Ionic Nitration and Acetylation of Aromatics." J. Amer. Chem. Soc., 94, 6862 (1972)

Olah, G. A., and Lin, H. C. Synthetic Methods and Reactions. VI. Boron Trifluoride Catalyzed Mononitration of Tetramethylbenzenes and Pentamethylbenzene with Methyl Nitrate in Nitromethane Solution. A New Selective Nitration Method. Synthesis, 490 (1973)

Olah, G. A. and Nojima, M. Synthetic Methods and Reactions VIII. Nitrofluorination of Alkenes. Synthesis, 785 (1973)

Olah, G. A., Lin, H. C., and Forsyth, D. A. Stable Carbocations. CLXXIV. Charge Distribution Differences in Benzenium and Nitrobenzenium Ions Based on ¹³C Nuclear Magnetic Resonance Studies and Their Relevance to the Isomer Distribution in Electrophilic Aromatic Substitutions. J. Amer. Chem. Soc., 96, 6908 (1974)

Olah, G. A., and Lin, H. C. Aromatic Substitution. XXXIV. The Differing Nature and Selectivity of the Nitration of Nitro(dinitro)benzene and toluenes from that of Benzene and Toluene. J. Amer. Chem. Soc., 96, 549 (1974)

Olah, G. A., and Lin, H. C. Aromatic Substitution. XXXV. Boron Trifluoride Catalyzed Nitration of Benzene, Alkylbenzenes, and Halobenzenes with Methyl Nitrate in Nitromethane Solution. J. Amer. Chem. Soc., 96, 2892 (1974)

Olah, G. A., and Lin, H. C. Synthetic Methods and Reactions. XI. A Convenient Direct Preparation of 1,3,5-Trinitrobenzene from m-Dinitrobenzene by Nitration with Nitronium Tetrafluoroborate in Fluorosulfuric Acid Solution. Synthesis, 444, (1974)

Olah, G. A., Germain A., Lin, H. C., Forsyth, D. A. Electrophilic Reactions at Single Bonds. XVIII. Indication of Protosolvated de facto Substituting Agents in the Reactions of Alkanes with Acetylum and Nitronium Ions in Superacidic Media. J. Amer. Chem. Soc., 97, 2928 (1975)

G. A. Olah, "Electrophilic Nitration" (invited paper presented at the Symposium on Industrial and Laboratory Nitration of the American Chemical Society, Philadelphia Meeting, April 1975, and manuscript submitted to Volume to be published by the American Chemical Society).

G. A. Olah, and H. C. Lin. Preparation of 1-Nitroadamantane from 1-Adamantyl Fluoroantimonate with Silver Nitrite. Synthesis (in press)